

Package ‘milr’

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Type Package

Title Multiple-Instance Logistic Regression with LASSO Penalty

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Description The multiple instance data set consists of many independent subjects (called bags) and each subject is composed of several components (called instances). The outcomes of such data set are binary or categorical responses, and, we can only observe the subject-level outcomes. For example, in manufacturing processes, a subject is labeled as “defective” if at least one of its own components is defective, and otherwise, is labeled as “non-defective”. The ‘milr’ package focuses on the predictive model for the multiple instance data set with binary outcomes and performs the maximum likelihood estimation with the Expectation-Maximization algorithm under the framework of logistic regression. Moreover, the LASSO penalty is attached to the likelihood function for simultaneous parameter estimation and variable selection.

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URL <https://github.com/PingYangChen/milr>

BugReports <https://github.com/PingYangChen/milr/issues>

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Imports utils, pipeR (>= 0.5), numDeriv, glmnet, Rcpp (>= 0.12.0),
RcppParallel

LinkingTo Rcpp, RcppArmadillo, RcppParallel

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milr-package	<i>The milr package: multiple-instance logistic regression with lasso penalty</i>
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Description

The multiple instance data set consists of many independent subjects (called bags) and each subject is composed of several components (called instances). The outcomes of such data set are binary or multinomial, and, we can only observe the subject-level outcomes. For example, in manufactory processes, a subject is labeled as "defective" if at least one of its own components is defective, and otherwise, is labeled as "non-defective". The milr package focuses on the predictive model for the multiple instance data set with binary outcomes and performs the maximum likelihood estimation with the Expectation-Maximization algorithm under the framework of logistic regression. Moreover, the LASSO penalty is attached to the likelihood function for simultaneous parameter estimation and variable selection.

References

1. Chen, R.-B., Cheng, K.-H., Chang, S.-M., Jeng, S.-L., Chen, P.-Y., Yang, C.-H., and Hsia, C.-C. (2016). Multiple-Instance Logistic Regression with LASSO Penalty. arXiv:1607.03615 [stat.ML].

DGP *DGP: data generation*

Description

Generating the multiple-instance data set.

Usage

```
DGP(n, m, beta)
```

Arguments

`n` an integer. The number of bags.
`m` an integer or vector of length `n`. If `m` is an integer, each bag has the identical number of instances, `m`. If `m` is a vector, the `i`th bag has `m[i]` instances.
`beta` a vector. The true regression coefficients.

Value

a list including (1) bag-level labels, `Z`, (2) the design matrix, `X`, and (3) bag ID of each instance, `ID`.

Examples

```
data1 <- DGP(50, 3, runif(10, -5, 5))
data2 <- DGP(50, sample(3:5, 50, TRUE), runif(10, -5, 5))
```

fitted.milr *Fitted Response of milr Fits*

Description

Fitted Response of milr Fits

Usage

```
## S3 method for class 'milr'
fitted(object, type = "bag", ...)
```

Arguments

`object` A fitted object of class inheriting from "milr".
`type` The type of fitted response required. Default is "bag", the fitted labels of bags. The "instance" option returns the fitted labels of instances.
`...` further arguments passed to or from other methods.

fitted.softmax	<i>Fitted Response of softmax Fits</i>
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Description

Fitted Response of softmax Fits

Usage

```
## S3 method for class 'softmax'
fitted(object, type = "bag", ...)
```

Arguments

object	A fitted object of class inheriting from "softmax".
type	The type of fitted response required. Default is "bag", the fitted labels of bags. The "instance" option returns the fitted labels of instances.
...	further arguments passed to or from other methods.

logit	<i>logit link function</i>
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Description

calculate the values of logit link

Usage

```
logit(X, beta)
```

Arguments

X	A matrix, the design matrix.
beta	A vector, the coefficients.

Value

An vector of the values of logit link.

milr	<i>Maximum likelihood estimation of multiple-instance logistic regression with LASSO penalty</i>
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Description

Please refer to [milr-package](#).

Usage

```
milr(y, x, bag, lambda = 0, numLambda = 20L, lambdaCriterion = "BIC",
     nfold = 10L, maxit = 500L)
```

Arguments

y	a vector. Bag-level binary labels.
x	the design matrix. The number of rows of x must be equal to the length of y.
bag	a vector, bag id.
lambda	the tuning parameter for LASSO-penalty. If lambda is a real value number, then the milr fits the model based on this lambda value. Second, if lambda is vector, then the optimal lambda value would be chosen based on the optimality criterion, lambdaCriterion. Finally, if lambda = -1, then the optimal lambda value would be chosen automatically. The default is 0.
numLambda	An integer, the maximum length of LASSO-penalty. in auto-tuning mode (lambda = -1). The default is 20.
lambdaCriterion	a string, the used optimality criterion for tuning the lambda value. It can be specified with lambdaCriterion = "BIC" or lambdaCriterion = "deviance".
nfold	an integer, the number of fold for cross-validation to choose the optimal lambda when lambdaCriterion = "deviance".
maxit	an integer, the maximum iteration for the EM algorithm. The default is 500.

Value

An object with S3 class "milr".

- lambdaa vector of candidate lambda values.
- cva vector of predictive deviance via nfold-fold cross validation when lambdaCriterion = "deviance".
- deviancea vector of deviance of candidate model for each candidate lambda value.
- BICa vector of BIC of candidate model for each candidate lambda value.
- best_indexan integer, indicates the index of the best model among candidate lambda values.
- best_modela list of the information for the best model including deviance (not cv deviance), BIC, chosen lambda, coefficients, fitted values, log-likelihood and variances of coefficients.

Examples

```

set.seed(100)
beta <- runif(5, -5, 5)
trainData <- DGP(70, 3, beta)
testData <- DGP(30, 3, beta)
# default (not use LASSO)
milr_result <- milr(trainData$Z, trainData$X, trainData$ID)
coef(milr_result)      # coefficients
fitted(milr_result)    # fitted bag labels
fitted(milr_result, type = "instance") # fitted instance labels
summary(milr_result)  # summary milr
predict(milr_result, testData$X, testData$ID)      # predicted bag labels
predict(milr_result, testData$X, testData$ID, type = "instance") # predicted instance labels

# use BIC to choose penalty
milr_result <- milr(trainData$Z, trainData$X, trainData$ID,
  exp(seq(log(0.01), log(50), length = 30)))
coef(milr_result)      # coefficients
fitted(milr_result)    # fitted bag labels
fitted(milr_result, type = "instance") # fitted instance labels
summary(milr_result)  # summary milr
predict(milr_result, testData$X, testData$ID)      # predicted bag labels
predict(milr_result, testData$X, testData$ID, type = "instance") # predicted instance labels

# use auto-tuning
milr_result <- milr(trainData$Z, trainData$X, trainData$ID, lambda = -1, numLambda = 20)
coef(milr_result)      # coefficients
fitted(milr_result)    # fitted bag labels
fitted(milr_result, type = "instance") # fitted instance labels
summary(milr_result)  # summary milr
predict(milr_result, testData$X, testData$ID)      # predicted bag labels
predict(milr_result, testData$X, testData$ID, type = "instance") # predicted instance labels

# use cv in auto-tuning
milr_result <- milr(trainData$Z, trainData$X, trainData$ID,
  lambda = -1, numLambda = 20, lambdaCriterion = "deviance")
coef(milr_result)      # coefficients
fitted(milr_result)    # fitted bag labels
fitted(milr_result, type = "instance") # fitted instance labels
summary(milr_result)  # summary milr
predict(milr_result, testData$X, testData$ID)      # predicted bag labels
predict(milr_result, testData$X, testData$ID, type = "instance") # predicted instance labels

```

predict.milr

Predict Method for milr Fits

Description

Predict Method for milr Fits

Usage

```
## S3 method for class 'milr'
predict(object, newdata = NULL, bag_newdata = NULL,
        type = "bag", ...)
```

Arguments

object	A fitted object of class inheriting from "milr".
newdata	Default is NULL. A matrix with variables to predict.
bag_newdata	Default is NULL. A vector. The labels of instances to bags. If newdata and bag_newdata both are NULL, return the fitted result.
type	The type of prediction required. Default is "bag", the predicted labels of bags. The "instance" option returns the predicted labels of instances.
...	further arguments passed to or from other methods.

predict.softmax	<i>Predict Method for softmax Fits</i>
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Description

Predict Method for softmax Fits

Usage

```
## S3 method for class 'softmax'
predict(object, newdata = NULL, bag_newdata = NULL,
        type = "bag", ...)
```

Arguments

object	A fitted object of class inheriting from "softmax".
newdata	Default is NULL. A matrix with variables to predict.
bag_newdata	Default is NULL. A vector. The labels of instances to bags. If newdata and bag_newdata both are NULL, return the fitted result.
type	The type of prediction required. Default is "bag", the predicted labels of bags. The "instance" option returns the predicted labels of instances.
...	further arguments passed to or from other methods.

softmax

*Multiple-instance logistic regression via softmax function***Description**

This function calculates the alternative maximum likelihood estimation for multiple-instance logistic regression through a softmax function (Xu and Frank, 2004; Ray and Craven, 2005).

Usage

```
softmax(y, x, bag, alpha = 0, ...)
```

Arguments

y	a vector. Bag-level binary labels.
x	the design matrix. The number of rows of x must be equal to the length of y.
bag	a vector, bag id.
alpha	A non-negative realnumber, the softmax parameter.
...	arguments to be passed to the <code>optim</code> function.

Value

a list including coefficients and fitted values.

References

1. S. Ray, and M. Craven. (2005) Supervised versus multiple instance learning: An empirical comparison. in Proceedings of the 22nd International Conference on Machine Learnings, ACM, 697–704.
2. X. Xu, and E. Frank. (2004) Logistic regression and boosting for labeled bags of instances. in Advances in Knowledge Discovery and Data Mining, Springer, 272–281.

Examples

```
set.seed(100)
beta <- runif(10, -5, 5)
trainData <- DGP(70, 3, beta)
testData <- DGP(30, 3, beta)
# Fit softmax-MILR model S(0)
softmax_result <- softmax(trainData$Z, trainData$X, trainData$ID, alpha = 0)
coef(softmax_result)      # coefficients
fitted(softmax_result)    # fitted bag labels
fitted(softmax_result, type = "instance") # fitted instance labels
predict(softmax_result, testData$X, testData$ID) # predicted bag labels
predict(softmax_result, testData$X, testData$ID, type = "instance") # predicted instance labels
# Fit softmax-MILR model S(3)
softmax_result <- softmax(trainData$Z, trainData$X, trainData$ID, alpha = 3)
```

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